REMARKS

The Examiner has rejected Claims 1-2, 10-15, 17-18, 20-23, and 27 under 35 U.S.C. 103(a) as being unpatentable over Press et al. ("Numerical Recipes in Fortran 77"), in view of Rumpf et al. ("Using Graphics Cards for Quantized FEM Computations"), and in further view of Roy-Chowdhury ("Algorithm-Based Error-Detection Schemes for Iterative Solution of Partial Differential Equations"). Further, the Examiner has rejected Claims 26, 28, and 30-31 under 35 U.S.C. 103(a) as being unpatentable over Press et al. ("Numerical Recipes in C"), hereinafter Press2, in view of Rumpf, and in further view of Roy-Chowdhury. Moreover, the Examiner has rejected Claim 29 under 35 U.S.C. 103(a) as being unpatentable over Press2, in view of Roy-Chowdhury, and in further view of Rumpf. Applicant respectfully disagrees with such rejections.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed.Cir.1991).

With respect to the first element of the *prima facie* case of obviousness, the Examiner has stated that "the motivation to use the art of Rumpf with the art of Press would have been the benefits recited in Rumpf that the presented strategy opens a wide area of numerical applications for hardware acceleration (***first page, Abstract, first paragraph***), and turns a graphics card into an ultrafast vector coprocessor (***first page, Abstract, first paragraph***), which would have been recognized by the ordinary artisan as

benefits that allow faster processing." Applicant respectfully disagrees with this proposition, especially in view of the vast evidence to the contrary.

For example, Press relates to implementing mathematics in software, while Rumpf relates to using graphics cards for quantized FEM computations. To simply glean features from a system for performing quantized FEM computations using graphics cards, such as that of Rumpf, and combine the same with the *non-analogous art* of software-implemented mathematics, such as that of Press, would simply be improper. Graphics cards provide broad access to graphics memory and parallel processing of image operands (see the Abstract of Rumpf), while software-implemented mathematics merely relates to using software to carry out mathematical operations. "In order to rely on a reference as a basis for rejection of an applicant's invention, the reference must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the inventor was concerned." In re Oetiker, 977 F.2d 1443, 1446, 24 USPQ2d 1443, 1445 (Fed. Cir. 1992). See also In re Deminski, 796 F.2d 436, 230 USPQ 313 (Fed. Cir. 1986); In re Clay, 966 F.2d 656, 659, 23 USPQ2d 1058, 1060-61 (Fed. Cir. 1992). In view of the vastly different types of problems software-implemented mathematics addresses as opposed to graphics cards, the Examiner's proposed combination is clearly inappropriate.

In addition, applicant respectfully asserts that the software mathematics of the Press and Press2 references are implemented using "Fortran 77" and "C" (see respective Titles), but are not disclosed to be directly on a graphics card. For example, Page 860 of Press discloses implementing "a routine for SOR with Chebyshev acceleration" in Fortran. Further, Rumpf discloses having to "approximate all involved nonlinear functions by linear in the implementation of the anisotropic diffusion" which "leads to an deterioration in image quality in the following timesteps," and that "the restricted precision of bits per color component leads to unsatisfying results for the linear heat equation… with very high relative errors" (Section 8, second column, paragraph 3 – emphasis added). Again, applicant respectfully asserts that the Examiner's proposed combination is clearly inappropriate in view of the vastly different types of problems

addressed by software-implemented mathematics as opposed to those addressed by graphics card-implemented quantized FEM computations.

Furthermore, Rumpf discloses that "many numerical algorithms still disregard hardware issues and little humps in the graphics hardware **still obstruct the passage to general fast numerical computations**" (Section 1, Goals, paragraph 4 – emphasis added). Applicant asserts that Rumpf's disclosure that many algorithms disregard hardware issues and that graphics hardware obstructs passage to general fast numerical computations clearly *teaches away* from the software-implemented general mathematics of the Press references. *In re Hedges, 783 F.2d 1038, 228 USPQ 685 (Fed. Cir. 1986).*

In the Office Action mailed 07/12/2007, the Examiner has argued that "the art of Rumpf and the art of Press are clearly analogous art for at least the reason that they both pertain to the art of solving partial differential equations (*Press, page 838, section 19.2, Diffusive Initial Value Problems; and Rumpf, section 6, Linear Heat Equation*)." Further, the Examiner has argued that "Rumpf continues, 'Hence even minor considerations of graphics hardware issues with respect to numerics on one side, and development of slightly more hardware sensitive algorithms on the other, could **result in revolutionary speedups for many applications**'" such that "Rumpf is clearly advocating the method for improving performance of applications."

Applicant respectfully disagrees and asserts that Press clearly teaches software implemented mathematics for diffusive initial value problems (Page 838, section 19.2), whereas Rumpf teaches "a graphics hardware solver for the linear heat equation" (Section 6 – emphasis added). Furthermore, Rumpf discloses that "many numerical algorithms still disregard hardware issues and little humps in the graphics hardware **still obstruct the passage to general fast numerical computations**," where "minor considerations of graphics hardware issues with respect to numerics, and the development of slightly more hardware sensitive algorithms on the other, could result in revolutionary speedups for many applications" (Section 1, Goals, paragraph 4 – emphasis added). Thus, as expressly taught by Rumpf, many numerical algorithms still disregard hardware issues, and **the**

development of slightly more hardware sensitive algorithms could result in revolutionary speedups for many applications, which clearly *teaches away* from using general mathematics which are not disclosed to even take into account hardware considerations, such as those originally disclosed by Press in 1986. Therefore, Rumpf advocates the development of more hardware sensitive algorithms, which fails to support the Examiner's proposed combination of combining the software implemented mathematics of Press with the graphics hardware implemented quantized FEM computations of Rumpf.

Also in the Office Action mailed 07/12/2007, the Examiner has argued that "hardware and software are equivalent (please refer to the new reference by Tanenbaum, Structured Computer Organization, 1984, page 11)." Applicant respectfully disagrees and asserts that the Examiner's reliance upon the Tanenbaum reference constitutes a reference(s) separate from those in the relevant rejection under 35 U.S.C. 103(a). Further, it is noted that the Examiner has failed to cite specific motivation in the relevant reference(s) to support the case for combining the Press, Rumpf, and Tanenbaum reference(s). The Examiner is reminded that the Federal Circuit requires that there must be some logical reason apparent from the evidence of record that would justify the combination or modification of references. *In re Regel*, 188 USPQ 132 (CCPA 1975). Thus, the reliance on the Tanenbaum reference(s), on its face, is clearly improper.

To this end, at least the first element of the *prima facie* case of obviousness has not been met, since it would be *unobvious* to combine the references, as noted above.

More importantly, with respect to the third element of the *prima facie* case of obviousness, the Examiner has relied upon Page 395, right-side column, and Page 400, left-side column from Roy-Chowdhury, in addition to Page 855, second paragraph from Press, to make a prior art showing of applicant's claimed technique "wherein the determining whether the solution has converged includes calculating errors and concluding that the solution has converged based on the calculation of the errors" (see this or similar, but not necessarily identical language in independent Claims 1, 10, 11, 26,

27, 28, and 30). Furthermore, in the Office Action mailed 07/12/2007, the Examiner has stated, in Section vii on Pages 13 and 14, that Press does not specifically teach applicant's claimed technique.

Applicant respectfully asserts that the excerpt from Press relied upon by the Examiner merely discloses that "the algorithm consists of using the average of *u* at its four nearest-neighbor points on the grid" which "is then iterated until convergence" (Page 855). Further, the excerpt from Press discloses this method as the "classical method... called *Jacobi's method*" (Page 855). However, the mere disclosure of Jacobi's method which iterates the use of the average of *u* at its four nearest-neighbor points until convergence, as in Press, simply fails to even suggest a technique "wherein the <u>determining **whether** the solution has converged</u> includes <u>calculating errors</u> and concluding that the solution has converged <u>based</u> on <u>the calculation of the errors</u>" (emphasis added), as claimed by applicant. Clearly, Jacobi's method, as in Press, simply fails to suggest "calculating errors," let alone "<u>concluding</u> that <u>the solution has converged based</u> on <u>the calculation of the errors</u>" (emphasis added), as claimed by applicant.

Further, applicant respectfully asserts that the excerpts from Roy-Chowdhury relied upon by the Examiner merely disclose that "[t]he expressions for updating errSR_ and errSB_ in each iteration... may be derived by summing over all red and black points" (Page 400). Further, the excerpts from Roy-Chowdhury disclose that "wherever error bounds for individual elements of u[i][j] arise in our error expressions, we drop them" (Page 400). However, the mere disclosure of <u>updating</u> errSR_ and errSB_ in <u>each iteration</u>, and <u>dropping error bounds</u> for individual elements when they arise in the error expressions, as in Roy-Chowdhury, simply fails to suggest a technique "wherein the <u>determining **whether** the solution has converged</u> includes <u>calculating errors</u> and concluding that the solution has converged <u>based</u> on <u>the calculation of the errors</u>" (emphasis added), as claimed by applicant.

Furthermore, applicant notes that Row-Chowdhury discloses that "[i]n this paper, we develop low-overhead, <u>error-detecting versions of iterative algorithms</u> for solving the

regular, spare linear systems which arise from discretizations of various partial differential equations (PDEs)" (Page 394, second column – emphasis added). Clearly, disclosing **error-detecting** versions of iterative algorithms, as in Row-Chowdhury, simply fails to even suggest that "determining **whether** the solution has converged includes calculating errors and concluding that the solution has converged based on the calculation of the errors" (emphasis added), in the manner as claimed by applicant.

In the Office Action mailed 07/12/2007, the Examiner has argued that "[t]he excerpt from Roy-Chowdhury needs to be evaluated in the context of the reference, especially the teaching that the termination condition for the iterative method is determined at runtime by specifying that the outer loop continue until the maximum difference over all grid points of a point value at the current iteration from its value at a previous iteration drops below a threshold (*page 395, right-side column, top half*)."

Applicant respectfully disagrees and asserts that Page 395, left column, last paragraph, from Roy-Chowdhury merely discloses that "[w]e may 'solve' the Laplace equation numerically over a region by discretizing it in the x and y directions to obtain a grid of points and then computing the approximate solution values at these points," such that "[t]he termination condition is determined at runtime by specifying that the outer loop continue until the maximum difference over all grid points of a point value at the current iteration from its value at the previous iteration drops below a threshold" (emphasis added). However, the mere disclosure of solving the Laplace equation by obtaining a grid of points and approximating a solution at these points until a point value in the current iteration drops below a threshold from its value in the previous iteration, as in Roy-Chowdhury, simply fails to even suggest that "determining whether the solution has converged includes calculating errors and concluding that the solution has converged based on the calculation of the errors" (emphasis added), in the manner as claimed by applicant. Clearly, simply teaching that a point value in the current iteration drops below a threshold from its value in the previous iteration, as in Roy-Chowdhury, fails to suggest "calculating errors," let alone "concluding that the solution has converged based on the calculation of the errors" (emphasis added), as claimed by applicant.

Further, in the Office Action mailed 07/12/2007, the Examiner has argued that "[i]n combination with the context, the disclosure for updating errSR_ and errSB_ in each iteration suggests [that] determining whether the solution has converged includes concluding that the solution has converged based on the calculation of said errors."

Applicant strongly disagrees, and asserts that Section 2.4 starting on Page 399 of Roy-Chowdhury describes the "Modified Algorithm with Checks and Error Bounding." Further, the sample code on the right column of Page 399 clearly illustrates that, inside the for loop "for (k=0; k<**iter**; k++)" (emphasis added), the red points are updated, then the red sums and error variables (SR, errSR_, errSR) are updated, and then the black points and black sums and error variables (SB, errSB_, errSB) are updated. Further, after the "for loop" iterates for "**iter**" iterations and completes (emphasis added), the error detection code then "check[s the] sum of the red points" and "check[s the] sum of the black points." Applicant notes that the error detecting code occurs after the "for loop" has iterated for "iter" iterations.

However, the error detecting SOR code that first iterates for **iter** iterations updating errSR_ and errSB_, and then, after the for loop completes, checks for errors and performs necessary "error()" handling functions, as in Roy-Chowdhury, simply fails to even suggest that "determining whether the solution has converged includes calculating errors and concluding that the solution has converged **based** on the calculation of the errors" (emphasis added), in the manner as claimed by applicant. Clearly, iterating for **iter** iterations and then checking for error conditions, as in Roy-Chowdhury, simply fails to suggest "**determining** whether the solution has converged includes calculating errors" and "**concluding** that the solution has converged **based** on the calculation of the errors" (emphasis added), in the manner as claimed by applicant.

Still yet, in the Office Action mailed 07/12/2007, the Examiner has argued that "the specification appears to be silent on the meaning of 'calculating errors.'" Applicant respectfully disagrees, and asserts that applicant's specification, as originally filed, is not

silent on "calculating errors," as alleged by the Examiner. For example, see Page 5, lines 4-9; Page 13, lines 4-8; and Page 17, lines 12-29 et al. Of course, such citations (in combination with the remaining specification) are merely examples of the above claim language and should not be construed as limiting in any manner.

Still yet, with respect to independent Claim 29, applicant respectfully asserts that such claim is deemed novel in view of the prior art excerpts relied on by the Examiner for at least substantially the same reasons argued above. For example, Claim 29 recites "determining whether the solution has converged by: calculating errors, summing the errors, and concluding that the solution has converged if the sum of errors is less than a predetermined amount" (emphasis added), as claimed, which is clearly not met by the prior art excerpts relied on by the Examiner, for substantially the same reasons as noted above.

To this end, applicant respectfully asserts that at least the first and third elements of the *prima facie* case of obviousness have not been met, since it would be *unobvious* to combine the references, as noted above, and the prior art excerpts, as relied upon by the Examiner, fail to teach or suggest all of the claim limitations, as noted above. Thus, a notice of allowance or a proper prior art showing of all of applicant's claim limitations, in combination with the remaining claim elements, is respectfully requested.

Applicant further notes that the prior art is also deficient with respect to the dependent claims. For example, with respect to Claim 13, the Examiner has relied upon Pages 854-856 in Press to make a prior art showing of applicant's claimed technique "wherein the relaxation operation is selected based on the partial differential equation." Specifically, the Examiner has argued that "it would have been obvious that the relaxation operation is selected on the partial differential equation, especially since such an example is presented."

Applicant respectfully disagrees and asserts that the excerpt from Press relied upon by the Examiner merely discloses that "relaxation methods involve splitting the

sparse matrix that arises from finite differencing and the iteration until a solution is found" (Page 854). For example, Press discloses a "method... called Jacobi's method" which "is not practical because it converges too slowly," in addition to "[t]he Gauss-Seidel method" which offers a "factor of two improvement in the number of iterations over the Jacobi method [which] still leaves the method impractical" (Pages 854-857). Clearly, Press is merely disclosing two different classical relaxation methods, the Jacobi's method and the Gauss-Seidel method, which clearly fails to support the Examiner's allegation that "it would have been obvious that the relaxation operation is selected on the partial differential equation," especially in view of applicant's claimed technique, namely "wherein the <u>relaxation operation</u> is <u>selected</u> **<u>based</u>** on the <u>partial differential equation</u>" (emphasis added), as claimed by applicant.

To this end, in response to the Examiner's argument that applicant's specific claim language would have been obvious, applicant again points out the remarks above that clearly show the manner in which some of such claims further distinguish Press. Applicant thus formally requests a specific showing of the subject matter in ALL of the claims in any future action. Note excerpt from MPEP below.

> "If the applicant traverses such an [Official Notice] assertion the examiner should cite a reference in support of his or her position." See MPEP 2144.03.

Further, with respect to Claim 18, the Examiner has relied on Page 855 from the Press reference to make a prior art showing of applicant's claimed technique "wherein it is determined whether the solution has converged after a predetermined number of multiple iterations of the relaxation operation." Further, the Examiner has stated that Press does not specifically teach that "[i]t is determined whether the solution has converged ***<u>after a predetermined number of multiple</u>*** iterations of the relaxation operation." Additionally, the Examiner has relied upon Official Notice and has stated that "processing time would be saved by testing convergence only after multiple iterations for a process that takes multiple iterations to converge." Specifically, as support for Official Notice, the Examiner has relied upon Galligani et al.

("Implementation of Splitting Methods for Solving Block Tridiagonal Linear Systems on Transputers"), Beckmann et al. ("Data Distribution at Run-Time: Re-Using Execution Plans"), and Y. Saad ("Krylov Subspace Methods for Solving Large Unsymmetric Linear Systems").

Applicant respectfully disagrees and asserts that the Examiner's reliance upon the Galligani, Beckmann, and Saad references constitutes a reference(s) separate from those in the relevant rejection under 35 U.S.C. 103(a). Further, it is noted that the Examiner has failed to cite specific motivation in the relevant reference(s) to support the case for combining the Galligani, Beckmann, and Saad reference(s). The Examiner is reminded that the Federal Circuit requires that there must be some logical reason apparent from the evidence of record that would justify the combination or modification of references. In re Regel, 188 USPQ 132 (CCPA 1975). Thus, the reliance on the Galligani, Beckmann, and Saad reference(s), on its face, is clearly improper.

In view of the Examiner's improper reliance on the Galligani, Beckmann, and Saad reference(s), and in response to the Examiner's reliance on Official Notice, applicant respectfully asserts that, in view of Press, it would not have been obvious to "[determine] whether the solution has converged after a predetermined number of multiple iterations of the relaxation operation," as claimed. Specifically, the excerpt from Press disclosing "interat[ion] until convergence," as relied on by the Examiner, merely relates to "a classical method with origins dating back to the last century, called *Jacobi's method*" (Page 855), which does not even suggest "a predetermined number of multiple iterations," as claimed. Thus, applicant again formally requests a specific showing of the subject matter in ALL of the claims in any future action (MPEP 2144.03).

In addition, with respect to Claim 21, the Examiner has relied on Page 395, right-side column, and Page 400, left-side column, from Roy-Chowdhury to make a prior art showing of applicant's claimed technique "wherein the determining whether the solution has converged further includes concluding that the solution has converged if an error is less than a predetermined amount."

Applicant respectfully disagrees and asserts that Page 395 from Roy-Chowdhury merely discloses that "[w]e may 'solve' the Laplace equation numerically over a region by discretizing it in the x and y directions to obtain a grid of points and then computing the approximate solution values at these points," such that "[t]he termination condition is determined at runtime by specifying that the outer loop continue until the maximum difference over all grid points of <u>a point value at the current iteration from its value at the previous iteration drops below a threshold</u>" (emphasis added). Further, applicant respectfully asserts that the excerpts from Roy-Chowdhury relied upon by the Examiner merely disclose that "[t]he expressions for updating errSR_ and errSB_ in each iteration... may be derived by summing over all red and black points," and that "wherever error bounds for individual elements of u[i][j] arise in our error expressions, we drop them" (Page 400). Additionally, Page 395 in Roy-Chowdhury discloses that "[w]e <u>omit the convergence check</u> in subsequent discussions since it has <u>no bearing</u> on the development of the <u>error-detecting algorithm</u>" (emphasis added).

However, the mere disclosure of solving the Laplace equation by obtaining a grid of points and approximating a solution at these points until a <u>point value in the current iteration drops below a threshold from its value in the previous iteration</u>, in addition to <u>updating</u> errSR_ and errSB_ in <u>each iteration</u>, and <u>dropping error bounds</u> for individual elements when they arise in the error expressions, as in Roy-Chowdhury, simply fails to suggest a technique "wherein the <u>determining</u> whether the <u>solution has converged</u> further <u>includes</u> <u>concluding</u> that the <u>solution has converged</u> if <u>an error is less than a predetermined amount</u>" (emphasis added), as claimed by applicant. Clearly, iterating until a point value in the current iteration drops below a threshold of its value in the previous iteration, in addition to dropping error bounds when they arise, as in Roy-Chowdhury, fails to disclose "<u>concluding</u> that the <u>solution has converged</u> if <u>an error is less than a predetermined amount</u>" (emphasis added), as claimed by applicant. Further, Roy-Chowdhury's teaching that the <u>convergence check</u> is omitted since it has <u>no bearing</u> on the development of the <u>error-detecting algorithm</u> does not teach "<u>concluding</u> that the

solution has converged if an error is less than a predetermined amount" (emphasis added), as claimed by applicant.

Furthermore, applicant asserts that Section 2.4 starting on Page 399 of Roy-Chowdhury describes the "Modified Algorithm with Checks and Error Bounding." Further, the sample code on the right column of Page 399 clearly teaches that, inside the for loop "for (k=0; k<**iter**; k++)" (emphasis added), the red points are updated, then the red sums and error variables (SR, errSR_, errSR) are updated, and then the black points and black sums and error variables (SB, errSB_, errSB) are updatec. Further, after the "for loop" iterates for "**iter**" iterations and completes (emphasis added), the error detection code then "check[s the] sum of the red points" and "check[s the] sum of the black points." Applicant notes that the error detecting code occurs after the "for loop" has iterated for "iter" iterations. Clearly, the Error detecting SOR code that first iterates for **iter** iterations updating errSR_ and errSB_, and then, after the for loop completes, checks for errors and performs necessary "error()" handling functions, as in Roy-Chowdhury, simply fails to even suggest a technique "wherein the determining **whether** the solution has converged further includes concluding that the solution has converged if an error is less than a predetermined amount" (emphasis added), as claimed by applicant.

Still yet, with respect to Claim 22, the Examiner has relied on Pages 838-840 in Press to make a prior art showing of applicant's claimed technique "wherein if it is determined that the solution has converged, repeating the processing using an altered parameter value." Specifically, the Examiner has argued that "especially note on page 840 below equation 19.2.12, the reference to stepsize Δt," and that "[t]he specification appears to provide a time value as an example of a parameter on page 5, line 9."

Applicant respectfully disagrees and asserts that the excerpt from Press teaches that in order "[t]o solve [the diffusion equation in one space dimension with a constant diffusion coefficient] one has to solve a set of simultaneous linear equations at each timestep for the u_j^{n+1}" (Pages 838-839). Further, the excerpt from Press teaches that "[t]he amplification factor for [the] equation (19.2.8) is... < 1 for any stepsize Δt" which

"is unconditionally stable" (Page 840). However, the mere disclosure of solving a set of simultaneous linear equations at each timestep in order to solve the diffusion equation, as in Press, simply fails to even suggest a technique "wherein if it is determined that **the solution has converged**, repeating the processing using an altered parameter value" (emphasis added), as claimed by applicant. Clearly, solving a set of simultaneous linear equations at each timestep, as in Press, simply fails to even suggest that "if it is determined that **the solution has converged**....the processing [is repeated] using an altered parameter value," where the solution is "the solution to the partial differential equation" (emphasis added), in the context as claimed by applicant (see Claim 1 for context).

Again, since at least the first and third elements of the *prima facie* case of obviousness have not been met, as noted above, a notice of allowance or specific prior art showing of each of the foregoing claim elements, in combination with the remaining claimed features, is respectfully requested.

To this end, all of the independent claims are deemed allowable. Moreover, the remaining dependent claims are further deemed allowable, in view of their dependence on such independent claims.

In the event a telephone conversation would expedite the prosecution of this application, the Examiner may reach the undersigned at (408) 505-5100. The Commissioner is authorized to charge any additional fees or credit any overpayment to Deposit Account No. 50-1351 (Order No. NVIDP074).

Respectfully submitted,
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